Agriculture in New York State: farm size and its implications to farmland protection and biodiversity conservation

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AGRICULTURE IN NEW YORK STATE: FARM SIZE AND ITS IMPLICATIONS TO FARMLAND PROTECTION AND BIODIVERSITY CONSERVATION

by

Julianna M. Potter

A Thesis
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Abstract

In the United States there are 939 million acres of land held by ranchers and farmers. Conservation of this agricultural landscape is critical to the protection of biodiversity. Management of agricultural land is also associated with the success of biodiversity protection efforts in protected areas, including parks and preserves, as well as outside protected areas. Sustained viability of the New York farming sector will enhance and secure biodiversity on farmland, as viable farms will remain part of the landscape.

In New York State there are over 7 million acres of farmland with varying capacities to support biodiversity. The purpose of this project was to determine which farm sizes are persisting in New York State’s landscape, and which farm sizes are faltering in order to find out which farm sizes are most likely to secure on-farm biodiversity. To accomplish this, I analyzed data from the United States Department of Agriculture to determine trends in variously sized farms. Four parameters -- number of farms, farmland acreage, gross sales, and gross sales per acre -- were used to elucidate trends at four farm sizes (small, small mid-size, large mid-size and large).

Small farms (1-49 acres) have elevated gross sales per acre, occupy minimal farmland, are growing in number, and are responsible for a very small amount of New York State’s gross agricultural sales. While there are more small mid-size farms (50-179 acres) than any other farm size, they occupy less than 20% of New York farmland, and are struggling with sales and sales per acre as evidenced by reduced gross sales and sales per acre. Large mid-size farms (180-499 acres) show a statistically significant downward trend in number of farms, farmland acreage, and gross sales, and have minimal gross
sales per acre. While there are fewer large farms (499 plus acres) than any other size they occupy a rising percentage of farmland, rising gross sales per acre, and the highest gross sales of all the farm sizes.

As large farms have a stable and dominant presence the vast amount of farmland associated with them must be valued as a key contributor to New York’s farmland biodiversity. However, small farms also show viable trends in more than one of the measurement parameters. It is this project’s premise that farms of all sizes should be valued as contributors to biodiversity.

Recognizing which farm sizes are viable and which farm sizes are struggling will allow policy makers to more appropriately direct efforts and attention towards vulnerable farm sizes, and focus biodiversity conservation efforts towards more viable farm sizes. Special attention must be paid to all mid-size farms as they are showing signs of struggling. These efforts will encourage a complete and intact agricultural landscape with increased security for biodiversity.
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1.0 Introduction

1.1 Biodiversity and Agriculture

Preservation of biological diversity - the number and variety of plants, animals, ecological communities, ecosystems and landscapes (Blann 2007) is crucial to sustaining human livelihoods, preserving the variety of living organisms, as well as the potential for organismal adaptation to environmental change (Convention on Biological Diversity 2009). The establishment of protected areas, such as parks and preserves has been the leading approach to conserving land (Naughton-Treves et al. 2005). The focus of conservation strategies needs to be expanded to consider biodiversity outside of protected areas (Franklin 1993, Daily et al. 2001, Polasky et al. 2005, Fischer et al. 2006). Matrix habitat, mixed landscapes outside of protected areas, often includes farmland. When matrix habitat is of high quality it is beneficial to the biodiversity within protected areas (Harvey et al. 2006, Vandermeer and Perfecto 2007). A diverse matrix also reduces isolation effects on biodiversity within larger island reserves (Donald and Evans 2006). As farmland may occupy much of this matrix, it is necessary that this land remains intact to provide corridors, and other beneficial habitat types for wildlife use (Vandermeer and Perfecto 2007).

Agriculture is, paradoxically, a contributor to the loss of biodiversity (Matson et al. 1997, Scherr and McNeely 2007), while at the same time, being instrumental in biodiversity preservation (Blann 2007, Fischer et al. 2006). In 2007, the Census for Agriculture reported that over seven million acres of land in New York State were being used for agriculture (United States Department of Agriculture 2010). Genetic diversity (the genetic variation in crops, livestock, and plants), species richness (the total number
of species present in a setting regardless of abundance), and ecosystem diversity (the variety of ecosystems within a larger landscape) are supported on agricultural land (Letourneau 2008).

1.2 Farmland Biodiversity Protection

Fully 25% of all land in New York State is used for agriculture (New York State Department of Agriculture and Markets 2007). Another 62% of New York’s land is forested, much of that either having been farmland at one time or currently in use for agro-forestry (New York State Department of Environmental Conservation 2010). As such, agricultural lands are among the major sources of undeveloped or minimally developed land in the state and for this reason, they are likely important to wildlife and biological diversity. Protecting farmland biodiversity is therefore essential (Jackson 2006, Norris 2008, Scherr and McNeely 2007, Fischer et al. 2008) to protecting New York State’s natural heritage and the ecosystem benefits that this diversity provides. Strategies for biodiversity conservation that fail to address farmland have difficulty succeeding (Scherr and McNeely 2002). However, because the numbers and kinds of species that can be supported by a landscape are thought to depend on the area of the landscape (MacArthur and Wilson 1967), farmland protection strategies and policies must consider the issue of farm size. In addition, if farm profitability varies with size, then policies regarding farmland protection should take size into account.
1.3 Farm Size in New York State

The goal of this project is to determine which farm size(s) (measured as acreage) within New York State is (are) succeeding (profitable) and, therefore, most likely to be sustainable into the future. By determining which size(s) of farms are succeeding and which are faltering, efforts to create agricultural policies that promote biodiversity conservation can be focused at profitable size scales and efforts to prevent farms from failing can focus on the needs of those size classes most at risk of failing. For instance, large farms tend to be suited to commodities markets, while small farms tend to be profitable through direct marketing (G. Kleppel unpublished ms). The economic policies required to facilitate successful agriculture at large scales, therefore, will be different from those that support small farms (Daniels 1999).
2.0 Background

2.1 Conservation of the Agricultural Landscape Matrix

As farmland occupies a vast amount of the New York State landscape, the conservation of farmland biodiversity must be considered. Agricultural land occupies a vast quantity of matrix habitat, mixed landscapes outside of parks and conservation areas, and has varying capacities to support biodiversity. Most protected areas are surrounded by agricultural land (Harvey et al 2008) and the use and management of this land will play an important role in conservation. Not only does high quality matrix habitat support higher levels of biodiversity, it compliments and helps increase the effectiveness and decrease the isolation of protected areas (Franklin 1993).

2.2 Farmland Conservation Programs

Federal and state policies that promote conservation of farmland, and biodiversity on farms are extremely important to the economic viability of farms in New York State. The applicability of these policies differs in part as a function of farm size. It is useful to review some of the key farmland conservation policies before proceeding further.

2.2.1 Natural Resource Protection Programs

Natural resource protection programs are designed to reduce soil erosion, enhance water quality, increase habitat for wildlife as well as mitigate damage caused by flooding and other natural disasters (Natural Resource Conservation Program - United States Department of Agriculture, 2011). These programs are voluntary and compensate farmers for eliminating or reducing agricultural activity on designated areas while
protecting natural settings (Haight et al. 2010). For example, the federally funded and operated Conservation Reserve Program (CRP) provides rental payments to farmers who convert erodible land to vegetative cover, while the state and federally funded Landowner Incentive Program (LIP) works with farmers and other landowners on habitat protection projects to protect threatened or endangered species. The New York State Department of Environmental Conservation (DEC) has designated at-risk bat species and endangered grassland bird species as LIP priorities in New York State (Haight et al. 2010). Conversely, completely resting a parcel of land may not be the best way to ensure its vigor (Savory 1999).

2.2.2 Environmental Management Programs

Environmental management programs aim to keep farm and forest land in active production while preserving natural resources (Haight et al. 2010). Programs are funded both by federal and state government and aim to protect water, soil, and air quality. The Environmental Quality and Incentive Program (EQIP) provides technical assistance and incentive or cost-share payments to farmers to use practices that improve environmental quality on farmland (Environmental Protection Agency 2011). Among the practices that EQIP funding can support are integrated pest management, manure management, wildlife habitat management and forest management.

2.2.3 Farmland Preservation and Protection

A number of planning tools are available for farmland preservation and protection (the two being different). Farmland preservation is permanent and is carried out by a
conservation easement that involves a legally binding agreement between a landowner and a land trust or government agency or public-private consortium (Daniels 2004). Conservation easements involve the landowner voluntarily and permanently donating or selling their development rights to a land trust or government agency. Permissible uses for a given parcel under a conservation easement are set forth by the land trust or agency holding the easement. The New York State Farmland Protection Program assists local governments in the permanent preservation of farmland within counties with approved Farmland Protection Plans by providing funds for the purchase of development rights on farms. The Program also assists counties in the development of Farmland Protection Plans.

Farmland protection is achieved through an array of tools (Daniels 2004). Farmland protection is less permanent than preservation and more likely to be altered by the political environment. Agricultural zoning, agricultural districting, urban growth boundaries, and Right to Farm Laws can all be used for farmland protection.

2.2.4 Tax Exemption, Farm Profitability and Farm Viability

To assist farmers in keeping business costs down, there are numerous programs designed to address the issue of tax relief for agricultural operations. Property and sales tax relief programs include Farm Building Exemptions, Sales Tax Exemptions, Forestland Exemption, Agricultural Assessment, and the New York State Conservation Easement Tax Credit. For example the New York State operated Forestland Exemption program offers landowners owning a minimum of 50 adjoining acres of forest, and
willing to commit the forestland to exclusively timber crop production, a reduction in their tax assessment (Haight et al. 2010).

Long-term farm profitability is vital to agricultural sustainability. There are a number of loan programs, certification programs, and grant programs that can be utilized to assist farmers in increasing their long-term profitability and assist new farmers in meeting startup costs. For example, New York’s Beginning Farmer Loan Program (BFLP) facilitates the provision of low-interest loans to beginning farmers for farming equipment and agricultural property. BFLP can also assist with transfer of farming businesses between generations.
3.0 Methods

3.1 Data

The United States Department of Agriculture (USDA), Census of Agriculture data was used to elucidate trends in New York State farm size. The USDA's aim in the collection and maintenance of this ongoing and inclusive database is to keep track of information regarding all commodities produced on farms in the United States (United States Department of Agriculture 2008). The USDA's definition of a farm is "any place from which $1,000 or more of agricultural products (crops and livestock) were sold or normally would have been sold during the year under consideration" (Economic Research Service 1993). Much of the data are available to the public.

3.1.1 Agriculture Census Data Collection

The primary data collection instrument for the agricultural censuses is a survey, distributed to the farming community and returned to the USDA by mail. Data were also collected for the 2007 Agriculture Census by electronic surveys. The Census mailing list is maintained by the National Agricultural Statistics Service (NASS) and includes a comprehensive inventory of all United States farmers and farms. Two follow-up mailings are sent out to non-respondents. Follow-up telephone calls are often made in a last effort to collect as much information as possible. Until 1992 the U.S. Census Bureau conducted the agriculture census. Since the 1997 Agriculture Census, the USDA has collected the data.
3.1.2 Adjustment for Coverage

Along with the change in data collection agency, came an alternative treatment of the way “non-respondent farmers” were handled. For census years prior to 1997, only farms that responded to the mailings were included in the data results, and raw, uncorrected figures were reported. In 1997, the USDA began to correct the data for those farmers who did not respond. The correction is called "adjustment for coverage." The goal of the adjustment for coverage correction is to increase the accuracy of the data source. The correction provides compensation for farm surveys that were not returned to the USDA.

The adjustment for coverage calculation is not a uniform formula applied to the raw data, but a mathematical equation derived for each census based on investigations of non-respondent farmers. The equation is derived from calculations of the number of non-respondent farmers. The USDA randomly selects tracts of land in each state where farms are counted by aerial survey, follow-up phone calls, and farm visits. The number of non-respondent farms influences the equation that is applied to the raw figures for the rest of the state. The equation applied to the raw data varies from one census to the next and is unique to the census for a particular year. A uniform adjustment to previous year’s data using a specific census’ percent difference would not be appropriate and would be less accurate than leaving the data set unadjusted (S. Schimonn, NASS, personal communication). While comparing census years, the adjustment for coverage must be taken into consideration when attempting to identify trends (Figure 1). Census years 1997, 2002, and 2007 have been adjusted for coverage and do indicate higher farmland acreage than in previous years. In 2002, the USDA retroactively determined the
adjustment for coverage for their previously collected 1997 census of agriculture. The reported farmland acreage total in 1997 was 7,254,470 while the adjusted total was 7,788,241, a 6.85% percent difference. For the sake of consistency with USDA protocol, no effort was made to correct the data for the change in computation procedures that occurred after 1992. The error introduced by not correcting the data is thought to be less than the error that would be introduced by altering the data (S. Schimonn, NASS, personal communication).

Figure 1 New York State Farmland Acreage since 1959. Black bars indicate years when census data was adjusted for coverage. (Data adapted from United States Department of Agriculture)
3.2 Area of Study

This project was confined to New York State. Farms in New York State vary in size from <1 acre to thousands of acres.

3.3 Farm Size Classification: Number of Acres

The classification method used to measure farm size for this project was number of acres under production. The USDA separates farms by number of acres into twelve size classes (Table I). A method for grouping farms into four size categories was devised (Table I) with guidance from the USDA Economic Research Service (ERS). The ERS considers “small” farms as less than 50 acres, “mid-size” farms as 50 to 499 acres, and “large” farms as more than 499 acres (United States Department of Agriculture 2009).

Due to the large number of farms within the mid-size category, I divided this category into two groups -- small mid-size and large mid-size farms to allow trends in these size classes to be more clearly resolved. Because there were 7 size classes within the mid-size category it was not possible to create two evenly sized groups. Therefore, four size classes were grouped as small mid-size farms and three size classes were grouped as large mid-size farms. Small mid-size farms are between 50 and 179 acres, while large mid-size farms are between 180-499 acres (Table I).
Table I Farm Size Categories (based on the USDA’s size classes)

<table>
<thead>
<tr>
<th>USDA Size Class</th>
<th>Acreage Group</th>
<th>Farm Size Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 9 acres</td>
<td>1-49 acres</td>
<td>Small</td>
</tr>
<tr>
<td>10-49 acres</td>
<td>50-179 acres</td>
<td>Small Mid-Size</td>
</tr>
<tr>
<td>50-69 acres</td>
<td>50-179 acres</td>
<td>Small Mid-Size</td>
</tr>
<tr>
<td>70-99 acres</td>
<td>180-499 acres</td>
<td>Large Mid-Size</td>
</tr>
<tr>
<td>100-139 acres</td>
<td>180-499 acres</td>
<td>Large Mid-Size</td>
</tr>
<tr>
<td>140-179 acres</td>
<td>180-499 acres</td>
<td>Large Mid-Size</td>
</tr>
<tr>
<td>220-259 acres</td>
<td>500 plus acres</td>
<td>Large</td>
</tr>
<tr>
<td>260-499 acres</td>
<td>500 plus acres</td>
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</tr>
<tr>
<td>500-999 acres</td>
<td>500 plus acres</td>
<td>Large</td>
</tr>
<tr>
<td>1,000-1,999 acres</td>
<td>500 plus acres</td>
<td>Large</td>
</tr>
<tr>
<td>2,000 + acres</td>
<td>500 plus acres</td>
<td>Large</td>
</tr>
</tbody>
</table>

3.4 Parameters Used to Measure Farming Success

To determine which size farms are successful and which are not, the behaviors of four variables -- number of farms, number of acres in farming, gross sales, and gross sales per acre -- were examined in relation to size trends over time. Temporal variations in the number and acreage of farms allow one to ascertain how the agricultural landscape is changing over time. Gross sales represents an analog to profitability across which farm size categories can be compared. Gross sales per acre is a measure of “financial
efficiency of a particular farm-size class” with respect to the space under cultivation. All of the variables are provided as part of the Census for Agriculture except gross sales per acre, which was calculated from the census data.

3.4.1 Number of Farms and Farmland Acreage

Data from Census of Agriculture Table 8 Farms, Land in Farms, Value of Land and Buildings, and Land Use: 1992 and 1987 (1997 and 1992, 2007 and 2002) was used for the number of farms and farmland acreage parameters.

3.4.1.1 Withheld Farmland Acreage Data

The USDA’s New York farmland acreage data is not all categorized into size classes; part of it is withheld (indicated by a “D” in the database). This lead to a discrepancy between true New York farmland acreage totals and categorized data totals available for observing size trends. A "D" represents data "withheld to avoid disclosing data for individual farms." Occurrences of the withheld data throughout the data set were more frequent for the acreage associated with the smallest and largest size classes. Therefore, acresages reported in farm size classes do not accurately represent the true total farmland acreage (Figure 2). Figure 2 illustrates the various censuses’ acreage totals (red line) that were available, and farmland acreage listed as total (blue line) by the USDA. The “categorized totals” were calculated by getting the sum of the acreage listed in size classes.

The average percent difference between the categorized data totals and the true New York farmland acreage totals for the censuses between 1987 and 2007 was 2.42%.
The largest percent difference, 5.50%, was associated with the 1987 census. The discrepancy between the categorized and true totals was deemed to be small and not likely to significantly alter the results of the study. For this project, the categorized data was needed to observe trends in farm size, and the discrepancy created by the withheld data will remain a limitation to the findings. From here on when a total is reported it indicates the total number of non-withheld farmland acres, not the true total of reported acreage to the USDA.

![Graph showing True and Categorized Farmland Acreage Totals](image)

**Figure 2** True and Categorized Farmland Acreage Totals (data adapted from the USDA Agricultural Census)
3.4.2 Gross Sales

Total agricultural sales was used as an indicator of trends in financial success in relation to farm size. Financial success of farming operations i.e., profitability is arguably associated with economic sustainability or viability. This thesis will address the question of whether or not one or more farm sizes is/are more likely to be viable than others. A farm size more likely to persist into the future is more apt to remain in the landscape. Sustainability or persistence of farmland has implications to biodiversity protection and conservation. Gross sales of each farm size was reported as a percentage of all New York State farm sales.

Values for gross sales were adjusted to reflect currency values over the time period studied. The percentages of inflation ranged from 2.28% to 2.96% over the time span analyzed (Dollar Times 2010). Gross sales values were multiplied by the current (2010) value of the US dollar for the given year (Figure 3) and the adjusted values were used in this analysis. For example, the 1992 gross sales values were multiplied by 1.71 as the dollar in 1992 was worth $1.71 in current currency (2010).
3.4.3 Gross Sales per Acre

Gross sales per acre was used to evaluate which farm size is more profitable based on its available farmland. This measure will indicate which size of agriculture is more efficient than the others. Gross sales per acre values were derived by dividing gross sales of a given farm size class by the total farmland acreage of that size class. This calculation provides a value that allows comparison of gross sales per acre of different size classes.
3.5 Time Span of Data Coverage

The time span covered in this project was determined by available and consistent data to observe trends. The data used to observe trends in gross sales and gross sales per acre cover a span of fifteen years from 1992 through 2007. The data used to measure trends in number of farms and number of acres in farming spans twenty years from 1987 through 2007.

3.6 Statistical Analysis

3.6.1 Parameter Means

Using Microsoft Excel (Version 14.2.2) means of the four farm size categories were calculated with respect to each of the four parameters to illustrate the average value of the parameters over the time span studied. Bar charts were used to graphically display the means with error bars indicating one standard deviation above the mean and one standard deviation below the mean to document the relative level of uncertainty about the means.

3.6.2 Least Squares Regression Analysis

Using Microsoft Excel (Version 11.6), linear regressions were generated from the categorized data to observe trends in the various measures of farming success. Slopes, r-values, and significance values for the trend lines were compared.

3.6.3 Correlation Analysis

Using SPSS (PASW Statistics 18) Pearson’s product-moment correlation coefficients were calculated to observe the amount of association between the parameters.
Relationships between the measurement parameters indicate whether the parameters were interacting with each other.
4.0 Results

4.1 Number of New York State Farms

During the 20-year time span covered by this project, the four measures of farming success that I evaluated have changed noticeably. On average over the time span studied the small mid-size category was the most abundant occupying 35.75% of New York farms while large farms were on average the least abundant farm size occupying 9.92% of New York farms (Fig 4 A). The greatest change in numbers of farms over the study period was in the large mid-size and small size categories (Fig 4 B). The number of large mid-size farms has decreased (slope (m)= -0.602, r = -0.97, p<0.05, Fig 4 B), while the number of small farms has increased (m = 0.5296, r=0.93, p<0.05, Fig 4 B). Among large farms the slope does not differ significantly from a slope of zero (m=-0.1058, r=-0.81, p>0.05, Fig 4 B), i.e., the number of farms did not change significantly over the study period. The small mid-size farm trend was slightly, but significantly positive (m=0.1786, r=0.94, p<0.05, Fig 4 B).
Figure 4 A) Average + SD Number of New York State Farms and B) Trends in Number of New York State Farms Between 1987 and 2007 (adapted from USDA Census of Agriculture 1987-2007) Bold = \( r \) is significant at \( p<0.05 \) or better.
4.2 New York State Farmland Acreage

On average over the time span studied large farms occupy the highest percentage of farmland with 41.47% of the New York agricultural landscape with large mid-size farms occupying 38.51% of the New York agricultural landscape (Fig 5 A). Farmland acreage in New York exhibits a gradual increase in land associated with small farms (m=0.073, r=0.88, p<0.05, Fig 5 B). Farmland associated with large farms also increased (m=0.4874, r=0.93, p<0.05, Fig 5 B). Farmland associated with large mid-size farms has steadily declined since 1987 (m=-0.704, r=-0.99, p<0.05, Fig 5 B). Farmland associated with small mid-size farms has not changed significantly with time (m=0.1252, r=0.79, p>0.05, Fig 5 B).
Figure 5 A) Average + SD New York Farmland Acreage and B) Trends in New York State Farmland Acreage Between 1987 and 2007 (adapted from USDA Census of Agriculture 1987-2007) Bold = $r$ is significant at $p<0.05$ or better.
4.3 New York State Agricultural Gross Sales

High gross sales suggest profitability. Growth in gross sales (i.e., a positive slope) suggests sustainability. Farms with increased gross sales will stabilize farmland, along with its accompanying biodiversity, more so than farm sizes that are not profitable and at risk of failing.

On average over the time span studied large farms have the highest gross sales with 50.92% of the states agricultural gross sales (Fig 6 A). The most extreme changes in farm gross sales in New York were in the large mid-size (m=-0.8992, r=-0.99, p<0.05, Fig 6 B) and large farm (m=0.9352, r=0.99, p<0.05, Fig 6 B) categories. The gross sales of large mid-size farms decreased from 35.97% to 22.50% of state agricultural sales, while the gross sales of large farms increased from 43.33% to 57.63% of state agricultural gross sales (Fig 6 B). The changes in gross sales percentages among small and small mid-size farms were not significant over the study period.
Figure 6 A) Average + SD New York State Agricultural Gross Sales B) Trends in New York State Agricultural Gross Sales Between 1992 and 2007 (Adapted from the USDA Census of Agriculture, 1992-2007) Bold = \( r \) is significant at \( p<0.05 \) or better
4.4 New York State Agricultural Gross Sales per Acre

Farm sizes with higher gross sales per acre are indicative of increased efficiency in the use of land (Fig 7 A). More efficient farm sizes will suggest farming that is better able to profitably produce agricultural products on its available farmland. On average over the time span studied, small farms have earned $1,669.58 per acre while large farms average the second highest with $670.16 per acre (Fig 7 A). As small farms in New York have the highest gross sales per acre, their decrease in efficiency over time was significant (m=-47.582, r= -0.90, p<0.05, Fig 7 B). Large farms are the second most efficient farm size category. The apparent increase in gross sales per acre for large farms was not significant. (m=11.419, r=0.67, p>0.05, Fig 7 B). Small mid-size and large mid-size farms show the lowest gross sales per acre; the time-varying changes in efficiency at these size categories were not significant (small mid-size; m=-7.5104, r=-0.24, p>0.05, large mid-size; m=-3.9922, r=-0.40, p>0.05, Fig 7 B).
Figure 7 A) Average $\pm$ SD New York State Agricultural Gross Sales per Acre and B) Trends in New York State Gross Sales per Acre Between 1992 and 2007 (Adapted from the USDA Census of Agriculture, 1992-2007) Bold $= r$ is significant at $p<0.05$ or better
4.5 Pearson’s Product-Moment Correlation Coefficients

Pearson’s product-moment correlation coefficients were generated to measure the strength of relationships between parameters (Table II). The number of farms was negatively correlated with gross sales ($r = -0.782; p<0.05$). The number of farms was also negatively correlated with total acreage ($r = -0.578; p<0.05$). Gross sales and total acreage are strongly correlated ($r= 0.896; p<0.05$). The association between sales per acre and total acreage exhibited a strong inverse correlation ($r= -0.671; p<0.05$).

Table II Pearson’s Product-Moment Correlation Coefficients (for associations between number of farms, total acreage, gross sales, sales per acre) (data adapted from the USDA agricultural census 1992-2007) Bold = $r$ is significant at $p<0.05$ or better

<table>
<thead>
<tr>
<th></th>
<th>Number of Farms</th>
<th>Total Acreage</th>
<th>Gross Sales</th>
<th>Sales per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of Farms</strong></td>
<td>1</td>
<td>-0.578</td>
<td>-0.782</td>
<td>-0.106</td>
</tr>
<tr>
<td><strong>Total Acreage</strong></td>
<td>1</td>
<td>0.896</td>
<td></td>
<td>-0.671</td>
</tr>
<tr>
<td><strong>Gross Sales</strong></td>
<td></td>
<td></td>
<td>1</td>
<td>-0.374</td>
</tr>
<tr>
<td><strong>Sales per Acre</strong></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>
5.0 Discussion

The results of this study show that the four parameters (number of farms, farmland acreage, gross sales and gross sales per acre) have changed over the time span covered. Small farms (1-49 acres) have elevated gross sales per acre, occupy minimal farmland, represent a growing number of operations, and are responsible for a very small amount of New York State’s agricultural gross sales. While there are more small mid-size farms (50-179 acres) than any other farm size, they occupy less than 20% of New York farmland, and seem to be struggling with sales (Fig 5 A) and sales per acre (Fig 5 B). Large mid-size farms (180-499 acres) show a statistically significant downward trend in number of operations, acreage, and gross sales. Large mid-size farms exhibit consistently low gross sales per acre. While there are fewer large farms (499 plus acres) than any other size category, they occupy a rising percentage of the land being farmed in New York, rising gross sales per acre, and the highest gross sales of all the farm sizes.

The goal of this project was to identify the most stable and therefore sustainable farm size category (ies) in New York State. It was suggested that there are obvious advantages to focusing farmland conservation and subsidy policies on successful and stable farming operations. My results indicate that small and large farm-size categories are strong in more than one area. Both size categories must be viewed as potential contributors to the preservation of New York’s agricultural biodiversity. Small and large farms appear to be more sustainable than mid-size farms. Mid-size farms appear to be vulnerable and at risk of failing. Large mid-sized farms appear not to be succeeding in any of the measurement areas studied.
5.1 Parameter Interactions

The Pearson’s product-moment correlation coefficients indicate that there is interaction between the parameters studied (Table II). The strong negative correlation coefficient between number of farms and gross sales \((r = -0.782; p<0.05)\) indicates that as gross sales decrease the number of farms within a size class increases (there are higher numbers of farms grossing less and fewer farms grossing more.) The negative correlation between number of farms and total acreage \((-0.578; p<0.05)\) suggests that as the number of farms within a size bracket decreases the number of acres associated within the size class increases (there are fewer large farms but more land is associated with them). Gross sales and total acreage are strongly correlated \((r= 0.896; p<0.05)\) indicating that as farm size increases so does gross sales (large farms gross more than small farms). The association between sales per acre and total acreage exhibited a strongly inverse correlation \((r=-0.671; p<0.05)\) illustrating that smaller farms (in this study’s case small farms) have higher sales per acre than larger farms.

5.2 Changing Composition of Farms in New York

The results of this study confirm two very different agricultural trends, and therefore unique implications for securing New York’s farmland biodiversity. First, that of large-scale agriculture is successful in New York State as indicated by rising sales per acre, rising percentage of New York State land in large farms and highest gross sales. Large farms are more likely to participate in and compete successfully in commodity production and marketing than small and mid-sized farms (Figs 4 and 5). The second agricultural trend is representative of small farms. The success of small farms (rising in
percentage of farms in the state, slowly rising percentage of total farmland, and a distinct efficiency shown in small farm sales per acre) is representative of this trend. Small farms are more likely to succeed in direct, consumer-based markets such as community supported agriculture programs and farmers markets.

The farm sizes that are not part of the success of either trend are both sizes of mid-size farms. Large mid-size farms are losing ground in all measures of farming success, while small-mid-size farms are losing ground in gross sales and sales per acre indicating financial vulnerability. These farm sizes appear to be unable to participate or compete in either trend. Mid-size farms may be too large to participate in direct marketing strategies of smaller farms and too small to compete successfully in the (volume-dependent) commodities markets.

The premise of this study is that farms of all sizes have value for biodiversity. Policy makers, however, should focus their efforts first to bolster farmland biodiversity on the most viable farms. It is clear from this study that small and large farms tend to be more viable than mid-sized farms. While, the protection of the whole spectrum of habitats is important for biodiversity conservation (Mikk and Mander 1995), large and small size farms are, at present, most likely to remain in our landscape. My results indicate that mid-sized farms are most vulnerable to failure, and most in need of measures to increase profitability. Once the viability of mid-sized farms is secured then policies directed at sustaining, even enhancing, biological diversity within this size class can by sought.
5.3 Species Area Relationship and Farmland

According to the theory of island biogeography (MacArthur and Wilson 1967), species richness varies as a power function of island area. Numerous factors other than island size influence the species richness of specific island areas, however, including level and length of isolation, habitat suitability, location, and human activity (MacArthur and Wilson 1967).

When farms are viewed as “islands”, large farms would be expected to provide habitat for a larger number of species than small farms. Large farms would be expected to have varying levels of natural habitat associated with them. Mikk and Mander (1995) reported a strong correlation between the number of woodland species and woodland patch size. Hence, as the acreage of a farm increases and assuming that natural area patch sizes increase as well, so can the number of species within the agricultural setting. According to the species-area relationship, preservation of large agricultural areas may be key to large-scale biodiversity conservation. Agricultural management practices including intercropping, crop rotations, agroforestry, and the use of living fences and windbreaks can all contribute to the enhancement of biological diversity in agricultural landscapes (Altieri 1999). However, when a landscape is simplified by a reduction in biodiversity that occurs with monocultures on industrial farms (which are often large farms), preservation of smaller, more heterogeneous farms may be more beneficial for the conservation of increased numbers of species.

Contrary to island biogeography theory, Zacharias and Brands (1990) illustrate in a study of vascular plant species richness that, on average, a single woodlot contains fewer species than two smaller ones of the same summed acreage as the larger woodlot,
while large woodlots include more rare species. In this respect, preserving the full spectrum of farm sizes may optimize for species richness, as well as increasing the potential for rare species to be preserved in larger natural areas that may exist on larger farms. Zacharias and Brands suggest, further, that conservation strategies be geared toward particular species and habitats rather than total species richness and land area. Wilsey et al. (2005) likewise suggest that protecting multiple smaller areas of different habitat types will enhance biodiversity more than protection of a large remnant of one habitat type. Natural habitat within small agricultural settings should also be valued as a contributor to biodiversity.

5.4 Land Sparing versus Land Sharing

As New York’s agricultural landscape is made up of variously sized farms, different strategies for nature conservation within agricultural settings will need to be employed. Land sparing and land sharing (the latter is also called wild-friendly farming) are two approaches used in varying sized agricultural landscapes to balance the preservation of biodiversity with agricultural demands (Fischer et al 2008). Land sparing involves designating tracts of land to be used intensely to maximize agricultural yield while other tracts nearby are left permanently for preservation of biodiversity (Green 2005). Although several USDA programs promote land sparing (see 2.0 Background section 2.2), publically owned parkland, rather than privately owned farmland is also commonly used to meet the criterion for “spared” land.

Wildlife-friendly farming generally produces lower yields per unit area (Green 2005) while mixing natural areas with planted crops or livestock farming. Characteristic
of this type of agricultural setting is an increase in landscape heterogeneity with areas of native vegetation mixed in with agricultural plantings or grazing in uncut pastures (Fischer et al. 2008). Agricultural landscapes with increased heterogeneity are usually thought to be able to support a greater diversity of species (Benton et al. 2003). Even at small scales, species richness responds to landscape variation (Weibull et al. 2003).

Land sparing and land sharing strategies are appropriate in different settings and can complement each other (Fischer et al. 2008), while farming operations may use a mixture of both strategies. Land sparing strategies are often appropriate for larger commodity producing operations (Fischer et al. 2008). Thus large farms in New York that tend to grow more monocultures and occupy less complex landscape matrices may be better suited to land-sparing strategies. New York’s smaller farming operations may be more apt to utilize alternative farming techniques (e.g., organic and biodynamic approaches) that increase biodiversity (see below), while often occupying more diverse landscape matrices. Land–sharing strategies may be suited to these smaller scale operations (Fischer et al. 2008).

5.4.1 Organic Agriculture

Smaller farms are more likely to use organic farming practices (Gabriel et al. 2009) and organic farms have also been found to be more biologically diverse (Gabriel et al. 2006). In 2007, 638 of the 36,352 farms in New York (about 1.7%) were certified organic. These occupied 168,400 acres (ca. 2%) of the 7,174,743 acres of farmland in the state (New York Farm Bureau 2010). Even though organic agriculture represents only a small percentage of total agriculture, it is considered a viable food production method
(Letourneau and Bothwell 2008). It is also noteworthy that many farms use organic methods, but are not certified (usually due to the costs associated with certification). These farms tend to be missed in the data on organic farming. Organic farming is, however, a growing alternative to conventional agriculture and can encompass nature conservation, reduction of pollutants, as well as agricultural production. As more than half of New York farms are small or small mid-size, organic farming may be a viable alternative to conventional farming practices for many New York farmers.

5.5 Diversification

In order to safeguard as much farmland biodiversity as possible the loss of mid-size farms must be considered. Mid-size farms have several options for increasing profitability. One option, promoted by state agricultural departments and county Cooperative Extension Services to reduce risk and increase profitability, is a diversification approach (American Farmland Trust 1998). Diversification can include expanding a mix of crops or livestock grown or raised on a farm, developing new services, or targeting additional markets (American Farmland Trust 1998). Opening of farm stores, delivery services, or other direct marketing avenues may increase profitability for struggling farms, particularly in the small mid-sized category. Co-op initiatives that include farmers, artisans, bakers, and other local craftsmen can reduce overhead costs for individuals and attract a wider spectrum of customers to events or markets.

There are several farms in Columbia County, New York that fall within the large mid-size category, which have diversified their operations. Golden Harvest Farm, in
northern Columbia County, has just over 200 acres in production and falls within the large mid-size category. Originally this farm produced only apples, but the operation has expanded to include a farm market (carrying their own produce along with other produce), increasing product variety to 21 different kinds of apple), pumpkins, baked goods, a micro-distillery producing apple vodka, a pick-your-own apple and pumpkin operation, hay rides, and other seasonal events (Golden Harvest Farm 2009). Hawthorne Valley Farm, which lies in central Columbia County, New York is a 400 acre biodynamic farm that includes a 60-cow herd along with its own Creamery for processing their milk, a community supported agriculture program, a number of on-farm learning programs, and several seasonal festivals (Hawthorne Valley Farm 2011). Hill Over Holsteins, a 180-acre farm in southern Columbia County, New York, has 72 dairy cows. The farm originally produced milk that was sold in bulk. Within the last year a self-serve milk store has been opened, and a home milk delivery service started in an effort to increase net income through direct marketing.

Additional options for diversification include agri-tourism. Permitting sporting activities such as hunting, fishing, or wildlife viewing on farms may capitalize on farmland’s biodiversity elements and increase a farm’s profitability. Farmers may rent appropriate areas to local sporting clubs. Farms are often scenic, and increasing public access to them may lead to increased income for farmers, and more connectivity for the public with their landscape.
5.6 Conclusion

Farms occupy most of the private land in the United States (Daniels 2004). In 2002, farmers and ranchers held 939 million acres (US Census of Agriculture 2002). While New York’s farming sector is made up of a full spectrum of size categories, farms of certain sizes – <49 acres and > 500 acres – appear more likely to be profitable than farms in mid-size categories. In order to secure farmland biodiversity within New York’s agricultural landscape, conservation strategies and policies need to be suited to a range of farm sizes, and in particular, focused on those most likely to succeed (while attempting to bolster the profitability, and hence sustainability, of farms in “at risk” size classes). Policies that help promote successful farming will facilitate the conservation of New York’s farmland biodiversity.
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